ORIGINAL ARTICLE

Validation of the Seattle Heart Failure Model (SHFM) in Heart Failure Population

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ABSTRACT

Objective: To determine the effectiveness of Seattle Heart Failure Model (SHFM) in a Pakistani systolic heart failure cohort in predicting mortality in this population.

Study Design: Cohort study.

Place and Duration of Study: The Armed Forces Institute of Cardiology - National Institute of Heart Diseases, Rawalpindi, from March 2011 to March 2012.

Methodology: One hundred and eighteen patients with heart failure (HF) from the registry were followed for one year. Their 1-year mortality was calculated using the SHFM software on their enrollment into the registry. After 1-year predicted 1-year mortality was compared with the actual 1-year mortality of these patients.

Results: The mean age was 41.6 ± 14.9 years (16 - 78 years). There were 73.7% males and 26.3% females. One hundred and fifteen patients were in NYHA class III or IV. Mean ejection fraction in these patients was 23 ± 9.3%. Mean brain natriuretic peptide levels were 1230 ± 1214 pg/mL. Sensitivity of the model was 89.3% with 71.1% specificity, 49% positive predictive value and 95.5% negative predictive value. The accuracy of the model was 75.4%. In ROC analysis, AUC for the SHFM was 0.802 ($p < 0.001$).

Conclusion: SHFM was found to be reliable in predicting one-year mortality among patients with heart failure in the Pakistani patients.

Key Words: *Heart failure. Pakistan. Brain natriuretic peptide. Seattle heart failure model (SHFM).*

INTRODUCTION

Heart failure (HF) is a clinical syndrome with considerable morbidity and mortality and incurs significant expense on any health care system.[1] The most recent data from the USA show that in 2008 the prevalence of HF in males and females age ≥ 20 years is 3% and 2% respectively. The incidence of HF in males and females age ≥ 45 years is 350,000 and 320,000 respectively. There were a total of 56,830 deaths due to heart failure in 2008. The total number of hospital discharges admitted initially as heart failure was 1,094,000 in 2009.[2] Risk stratification and prognosis assignment are an integral part of the management of heart failure so that these patients may be counselled about their prognosis and referred appropriately for advanced therapies such as cardiac resynchronization therapy (CRT), implantable cardioverter defibrillators (ICDs) and eventually heart transplantation (HT). Different prognostic calculating systems have been devised for this population. The Seattle heart failure model (SHFM) is one of them. The cut off line for referring for heart transplantation is when the 1-year predicted mortality is ≥ 20% (or 1-year survival > 80%).[3]

The Seattle heart failure model (SHFM) has never been tested in Pakistani population so the study was conducted to apply this scoring system to a Pakistani systolic heart failure cohort for validation in this population.

METHODOLOGY

A total of 118 patients with systolic HF from registry were followed for one year. Patients with heart failure with reduced ejection fraction (< 40% as per definition of heart failure) were included while those with preserved ejection fraction or diastolic heart failure were excluded. Their mortality was calculated on the SHFM software on their enrollment into the registry. The SHFM employs 21 easily available clinical and laboratory variables (Figure 2). After following them for 1-year the predicted 1-year mortality from the SHFM was compared with the actual 1-year mortality of these patients. Because the cut off line for referral for heart transplant is a 1-year mortality of ≥ 20%, the ability of the SHFM model to predict a 1-year mortality of ≥ 20% was compared with the actual 1-year mortality.

The statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 19. Descriptive statistics were used to describe the data i.e.

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mean and standard deviation (SD) for quantitative variables while frequency along with percentages for qualitative variables. The sensitivity, specificity, negative and positive predictive values of the SHFM were calculated. The receiver operator characteristic curve (ROC) was generated and area under the curve (AUC) was calculated. P-value < 0.05 was considered as significant.

RESULTS

In the total population of 118 patients mean age was 41.6 ± 14.9 years. Males were 73.7% and females 26.3%. NYHA class distribution of the patients on enrollment is shown in Table I. Mean ejection fraction in these patients was 23 ± 9.3%. Mean brain natriuretic peptide levels were 1230 ± 1214 pg/mL. Average I-year mortality was 22.77 ± 13.83% (minimum 4 - 72%). At the end of one-year, 90 patients were alive while 28 were dead. The SHFM model had predicted a > 20% 1-year mortality for 51 patients. Of these, 25 patients were dead while 26 were still alive. The model had predicted a 1-year mortality of < 20% for 67 patients. Of these, 3 were dead and 64 were alive at the end of 1-year. Sensitivity of the model was 89.3% and specificity was 71.1% with 49% positive predictive value (PPV) and 95.5% negative predictive value (NPV). The accuracy of the model was 75.4%. In ROC analysis, AUC for the SHFM was 0.802 (p < 0.001). The ROC curve is shown in Figure 1.

Table I: Description of NYHA class of the patients (n = 118).

NYHA class	Frequency	Percentage
I	1	0.8
II	2	1.7
III	78	66.1
IV	37	31.4

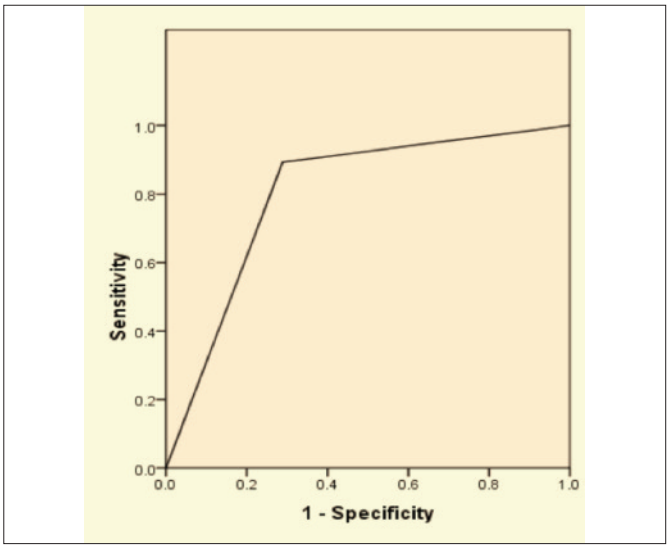

Figure 1: ROC curve of SHFM against actual mortality (n = 118).

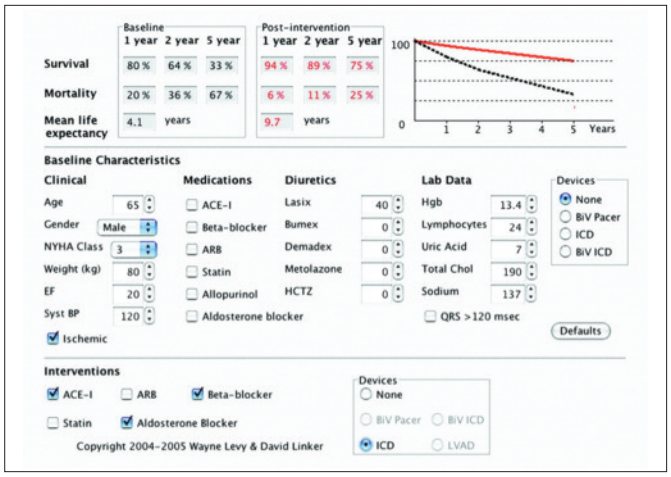

Figure 2: Seattle heart failure model software.

DISCUSSION

Heart failure is a chronic syndrome of cardiovascular decompensation with detrimental systemic effects. Different trials of Beta blockers, angiotensin converting enzyme inhibitors and angiotensin receptor blockers have shown an improvement in the quality of life and reduction in mortality.[4-7] Cardiac resynchronization therapy has also played a significant role to improve quality of life and reduce mortality in these patients.[8]

Two commonly used scoring systems to predict mortality, survival and risk include the Seattle heart failure model (SHFM) and the heart failure scoring system (HFSS). Both these models are computer based calculators that use patients' clinical and laboratory variables to generate a composite score and predict risk. Although most centres employ both models, and combining the HFSS and SHFM has been shown to improve predictive ability,[9] the SHFM is more commonly used for its ease of use in the out-patients setting. When the 1-year predicted mortality for the patient on SHFM exceeds 20%, the patient is referred for heart transplantation.

The SHFM employs 21 easily available variables (Figure 2). It was developed in a cohort of 1125 patients in the PRAISE1 trial,[10] using a multivariate Cox model. This trial included patients with an EF < 30% and NYHA class IIIB and IV. The SHFM was validated in 9,942 patients, from 5 cohorts. The trial cohorts to which it was applied include the ELITE-2, VALHeFT, UW study, RENAISSANCE study and the IN-CHF registry.[11-15] Validation of the model in these trials to predict survival showed this model to be highly accurate, with ROC for predicting one year mortality being 0.75-0.80.[16]

Of note, the SHFM does not include blood urea nitrogen (BUN) or serum creatinine. The incremental value of BUN over the SHFM was tested in 443 patients in another study. Although BUN had the strongest

association with outcomes in patients with advanced HF in this study; the incremental value of renal function over the SHFM for risk determination was marginal.[17] Attempts to validate the model in other studies have been made as well with variable results. The model was tested in a study of 445 patients with advanced HF, it was found to underestimate the absolute risk, especially in blacks and in patients with devices.[18]

Application of the model to 10,538 patients concluded that the SHFM score provides information about the likely mode of death among ambulatory heart failure patients (ventricular arrhythmia vs. pump failure).[19] This analysis is excluded in the present study. The model also allows for predicting the effect of medications and devices on survival and mortality. As a practical application, the SHFM may facilitate identification of high-risk patients to further evaluate them for potential LVAD implantation by providing an estimate of 1-year survival with medical therapy.[20,21]

This study cohort closely matched that of the initial derivation and validation cohort for the SHFM. The mean EF of study patients was 23%, and except 3 patients all of them were either in NYHA class III or IV. This study found the sensitivity of the SHFM to be high (89.3%) along with a high negative predictive value (95.5%) in predicting the 1-year mortality of these heart failure patients. The AUC in ROC analysis for predicting 1-year mortality was high (0.80, $p < 0.001$) which was within the range of the validation cohort.[16] The accuracy of the model was 75.4%. The reason for the lower specificity and positive predictive value could be the small number of cases. The authors feel that while this study has shown the model to be reliable in terms of AUC values and sensitivity, a larger cohort of heart failure patients is needed to further demonstrate better positive predictive values and specificity in our population.

Using the SHFM in routine clinical practice allows one to provide the service and the patient with an evidence based risk stratification by combining a broad range of clinical and laboratory parameters. This allows planning of future evidence management of these patients.

CONCLUSION

The study found the SHFM to be reliable in predicting one year mortality among patients with heart failure in the Pakistani patients.

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